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National Bureau of Standards

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TENSILE AND COMPRESSIVE TESTS OF MAGNESIUM ALLOY J-1 SHEET

By C. S. Aitchison and James A. Miller

SUMMARY

Tensile and compressive stress-strain curves, stress-deviation curves, and secant modulus-stress curves are given for longitudinal and transverse specimens of magnesium alloy J-1 sheets 0.032 and 0.102 inch thick.

Significant differences were found between the tensile and compressive stress-strain curves and between the compressive stress-strain curves for the longitudinal and transverse directions. The differences between longitudinal and transverse compressive properties are brought out further by giving curves of tangent modulus and of reduced modulus for a rectangular section.

The results for the magnesium alloy sheet differed from those for the aluminum alloy, carbon steel, and stainless steel sheets described in NACA T.N. 840 in that the tensile stress-strain curves continued to climb steeply beyond the yield strength, while the compressive stress-strain curves were smooth below the yield strength and then approached a horizontal asymptote at the yield strength.

INTRODUCTION

This paper describes a continuation of the work, reported in reference 1, of assembling tensile and compressive stress-strain data on sheet metals used in aircraft to provide an experimental background for a study and classification of such data. This work has been conducted at the National Bureau of Standards with the support of the National Advisory Committee for Aeronautics.

MATERIAL

The sheets were of magnesium alloy J-1 in the hard temper (Navy Department designation: 8H), 0.032 and 0.102 inch thick, obtained in 1940 from the Dow Chemical Company.

TENSILE TESTS

The tensile specimens were taken from each sheet in the lengthwise (longitudinal) and crosswise (transverse) directions. They were type 5 specimens described in reference 2 and complied with specifications in reference 3. They were tested in a hydraulic machine in the same manner as the tensile specimens in reference 1.

The stress-strain curves, stress-deviation curves, and secant modulus-stress curves, derived as in reference 1, are shown in figures 1 and 2.

The results of the tensile tests and the tensile properties prescribed for sheet magnesium-base alloy 8H in Navy Department Specification 47M2a, December 1, 1942, are given in table I. The experimental values of Young's modulus and yield strength were determined as described in reference 1.

Both sheets pass current tensile specification requirements for magnesium alloy 8H.

COMPRESSIVE TESTS

The compressive tests were made with a subpress (reference 4) in a beam and poise, screw-type testing machine.

The tests on the 0.032-inch sheet were made on packs consisting of 5 specimens. The packs were tested with their ends clamped in the grips of the subpress. They differed from the conventional flat-end packs described in reference 5 in the following particulars.

The middle specimen was 0.52 inch wide and the supporting specimens were 0.50 inch wide. The specimens were cemented together as follows. The specimens were coated with Bostick cement. After drying over night they were pressed together at a temperature of 64°C for $4\frac{1}{2}$ hours in a jig similar to that described in reference 6 but without end clamps. The packs were ground to length, 3.24 inch. The free length of each pack was 2.10 inches. Lateral support against premature buckling was provided on each side of the pack by 33 pins in 3 columns and 11 rows spaced on $3/16$ -inch centers.

The tests on the 0.102-inch sheet were made on single specimens 0.50 inch wide by 3.24 inches long. They were tested in the same way as the packs of the 0.032-inch sheet.

The strain was measured by a pair of Tuckerman 1-inch optical strain gages attached on opposite edge faces of the specimen.

The stress-strain curves, the stress-deviation curves, the secant modulus-stress curves, the tangent modulus-stress curves, the non-dimensional tangent modulus-stress curves, and reduced modulus (rectangular cross section) -stress curves are shown in the figures. They were derived as described in reference 1.

The results of the compressive tests are given in table II. The experimental values of Young's modulus and yield strength were determined as described in reference 1.

The values of compressive yield strength were lower than the specified minimum values for tensile yield strength.

CONCLUSIONS

The tensile properties of the sheet were well above those specified, for sheet magnesium-base alloy 8H in Navy Department Specification 47M2a, December 1, 1942. The results cannot be considered as representative, therefore, of material just meeting specifications.

The longitudinal and transverse tensile curves were in close agreement throughout most of the range for which the strain was measured; the yield strengths differed by less than 2 percent. The compressive yield strengths in the longitudinal direction were significantly lower than in the transverse direction and both were much less than the corresponding values in tension.

The results for the magnesium alloy sheet differed from those for the aluminum alloy, carbon steel, and stainless steel sheets described in NACA T.N. 840 in that the tensile stress-strain curves continue to climb steeply beyond the yield strength, while the compressive stress-strain curves were smooth below the yield strength and then approached a horizontal asymptote at the yield strength.

National Bureau of Standards,
Washington, D. C., October 1, 1943.

REFERENCES

1. Aitchison, C. S., and Miller, James A.: Tensile and Pack Compressive Tests of Some Sheets of Aluminum Alloy, 1025 Carbon Steel, and Chromium-Nickel Steel, T.N. No. 840, NACA, 1942.
2. Anon.: General Specification for Inspection of Metals. Federal Specification: QQ-M-151a, Federal Standard Stock Catalog, sec. IV, pt. 5, Nov. 27, 1936.
3. Anon.: Tentative Methods of Tension Testing of Metallic Materials. 1940 Supplement to A.S.T.M. Standards, pt. I, Metals. (E 8-40T), A.S.T.M. (Philadelphia), pp. 453-463.
4. Aitchison, C. S., and Miller, James A.: A Subpress for Compressive Tests. T.N. No. 913, NACA, 1943.
5. Aitchison, C. S., and Tuckerman, L. B.: The "Pack" Method for Compressive Tests of Thin Specimens of Materials Used in Thin-Wall Structures. Rep. No. 649, NACA, 1939.
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TABLE I.- RESULTS OF TENSILE TESTS

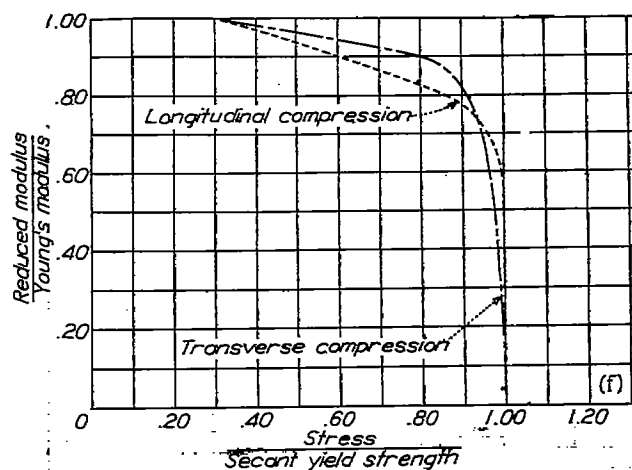
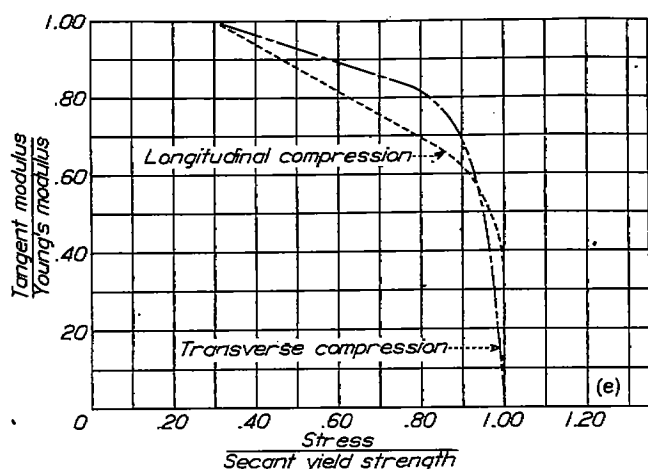
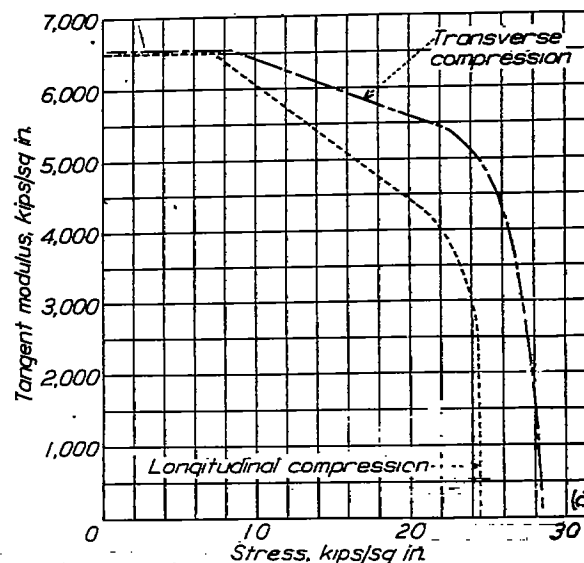
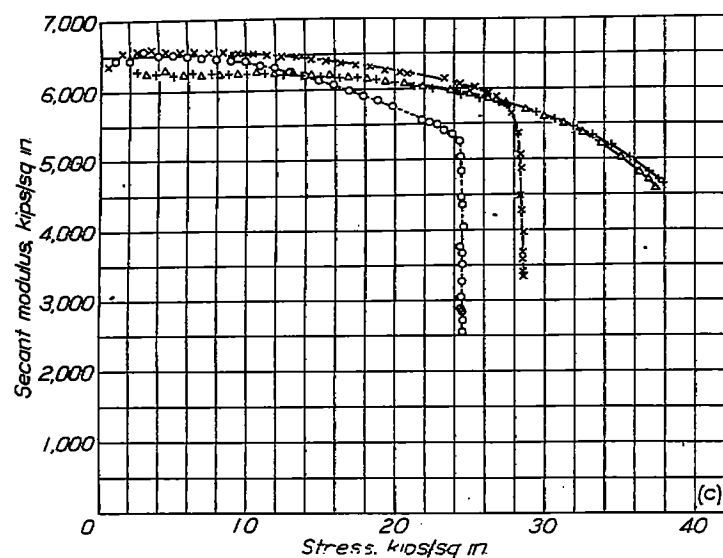
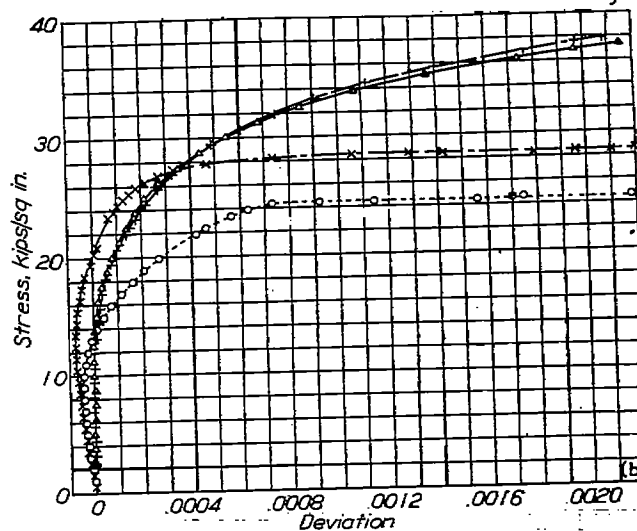
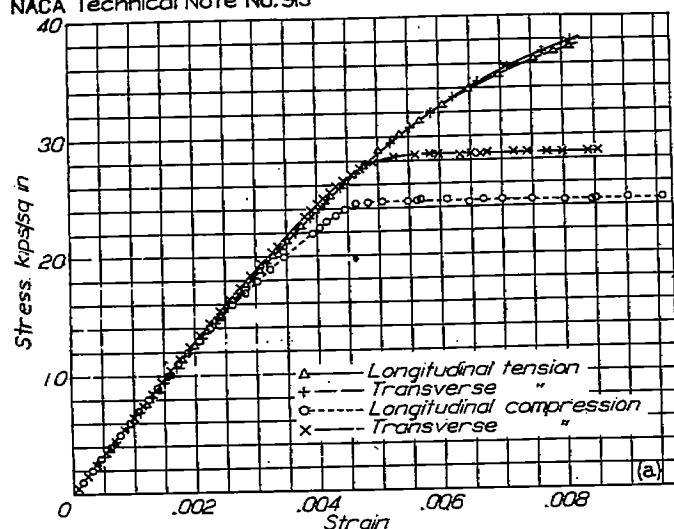
Sheet	Material	Nominal thickness of sheet (in.)	Direction	Specification values					Test results				
				Strain prescribed for yield strength, extension under load	Young's modulus	Minimum yield strength	Minimum tensile strength	Minimum elongation in 2 inches	Young's modulus	Yield strength		Tensile strength	Elongation in 2 inches
					(kips/sq in.)	(kips/sq in.)	(kips/sq in.)	percent	(kips/sq in.)	Offset method, offset = 0.2 percent	Extension under load method	(kips/sq in.)	percent
21	Magnesium alloy J-1h	0.032	Longitudinal	0.0063	6,500	32.0	40.0	3.0	6,250	37.0	33.3	44.8	8.0
				.0063	6,500	32.0	40.0	3.0	6,250	37.7	33.4	47.3	12.0
22	Magnesium alloy J-1h	.102	Longitudinal	.0063	6,500	32.0	40.0	3.0	6,280	38.3	34.0	47.2	9.5
				.0063	6,500	32.0	40.0	3.0	6,370	38.1	33.6	49.4	13.5

*Computed from specified yield strength, specified extension under load and an offset of 0.2 percent.

TABLE II.- RESULTS OF COMPRESSIVE TESTS

Sheet	Material	Nominal Thickness of sheet (in.)	Direction	Number of specimens in a pack	Young's modulus	Secant modulus	Yield strength	
							Offset method, offset-0.2 percent	Secant method
					(kips/sq in.)	(kips/sq in.)	(kips/sq in.)	(kips/sq in.)
21	Magnesium alloy J-1h	0.032	Longitudinal	5	8,500	4,440	24.5	24.5
				5	8,550	4,470	28.5	28.5
22	Magnesium alloy J-1h	.102	Longitudinal	Note	8,460	4,410	27.0	27.0
				Note	8,520	4,450	30.2	30.2

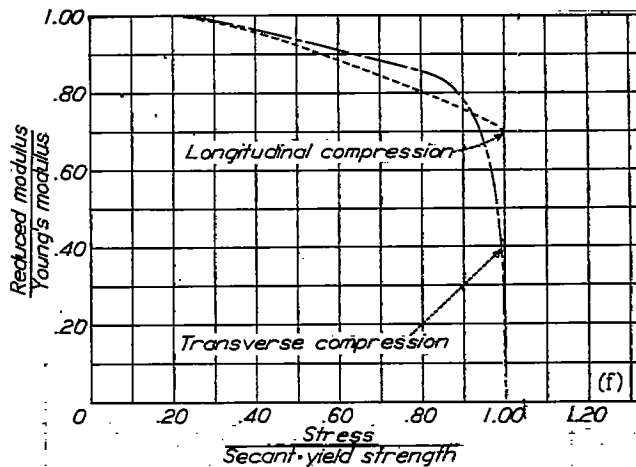
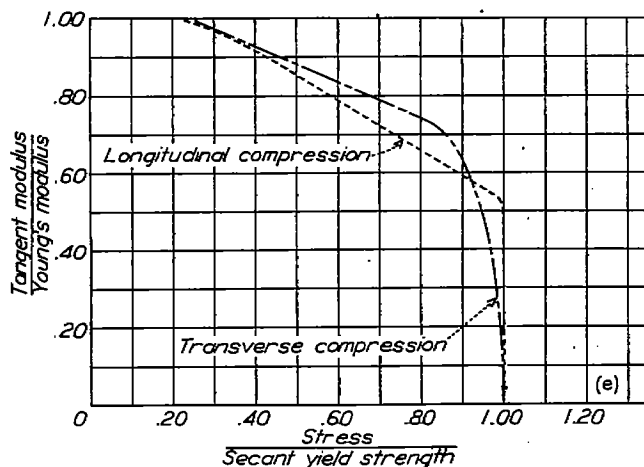
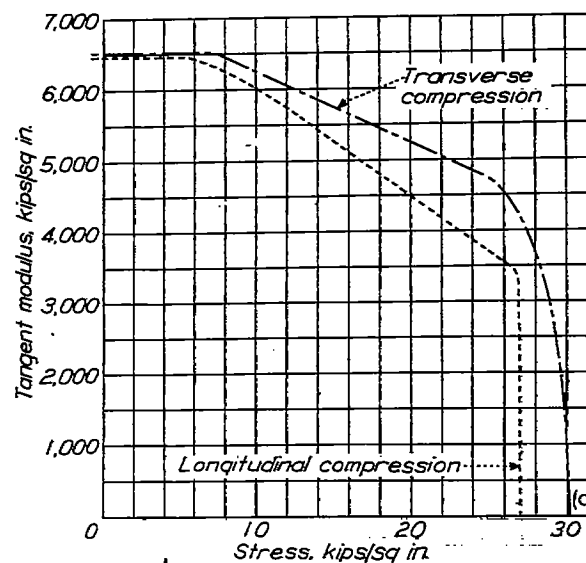
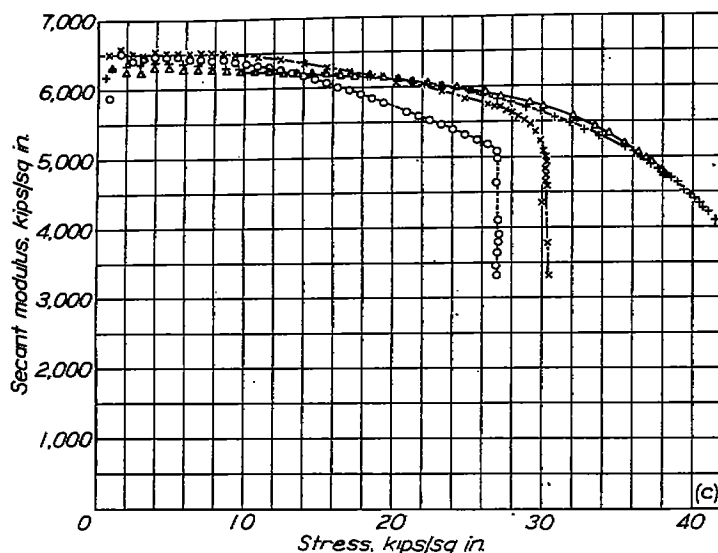
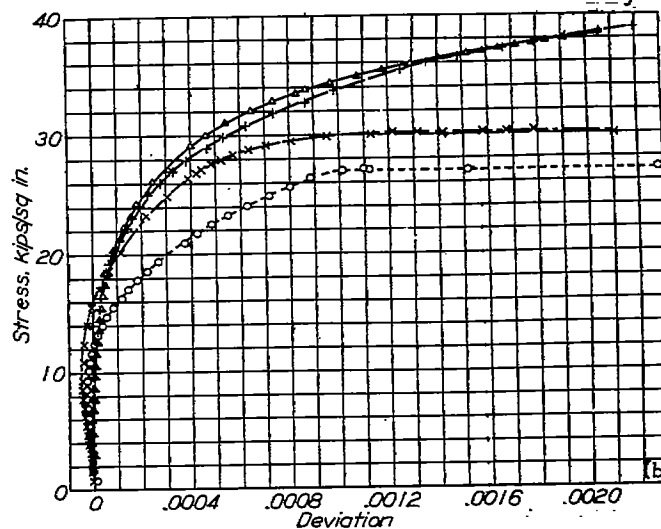
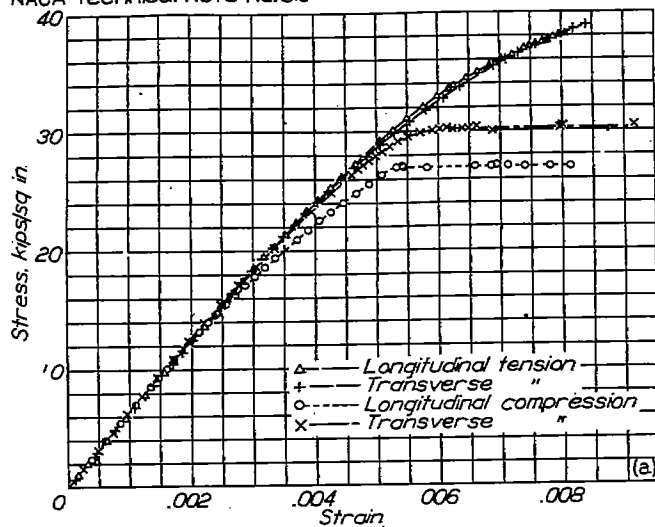
Note: Single Specimen



- (a) Stress-strain curves.
(c) Secant modulus-stress curves.
(e) Nondimensional tangent modulus-stress curves.

- (b) Stress-deviation curves.
(d) Tangent modulus-stress curves.
(f) Nondimensional reduced modulus-stress curves.

Figure 1.- Sheet 21. Magnesium alloy J-1h, thickness 0.032 inch.



(a) Stress-strain curves.

(c) Secant modulus-stress curves.

(e) Nondimensional tangent modulus-stress curves.

(b) Stress-deviation curves.

(d) Tangent modulus-stress curves.

(f) Nondimensional reduced modulus-stress curves.

Figure 2.- Sheet 22. Magnesium alloy J-1h, thickness 0.102 inch.